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# New Horizons

## Student Dust Counter (SDC)

### PDS Peer Review

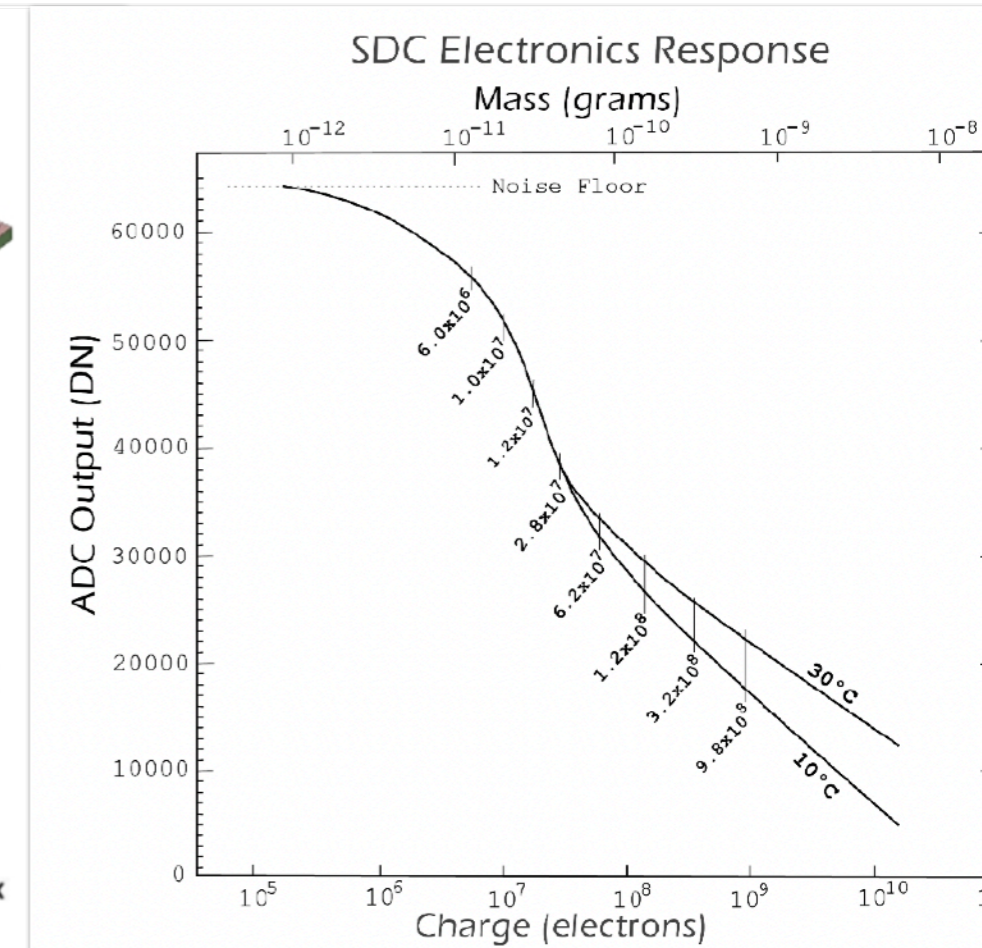
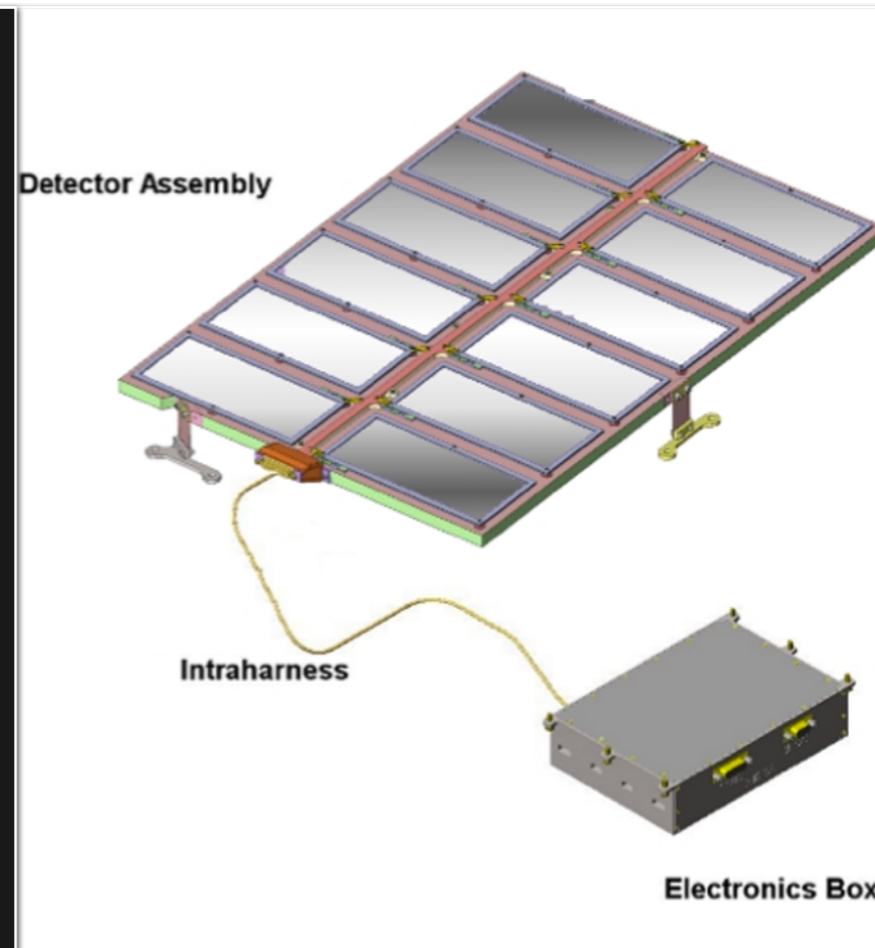
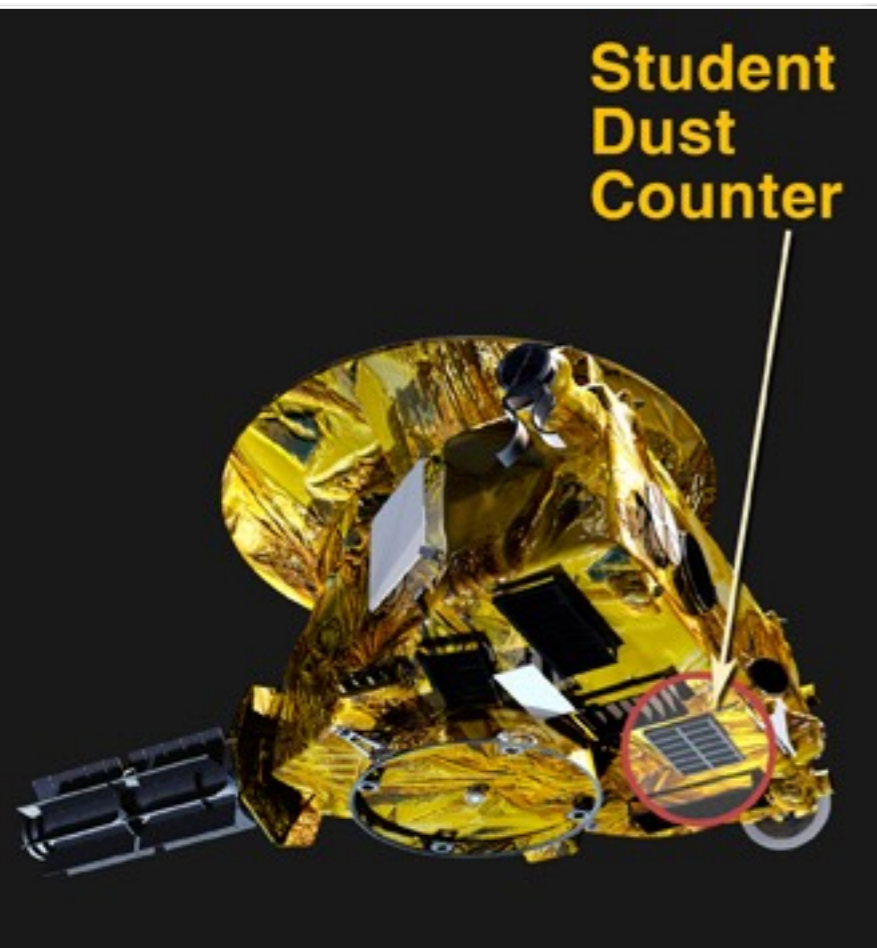
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University of Colorado, Boulder (CU)

Jan. 22, 2024

## SDC instrument:

- 14 PVDF detectors: 12 science (with 1 defunct), 2 reference
- Electronics box for signal processing, telemetry/commands



## Principle of operation:

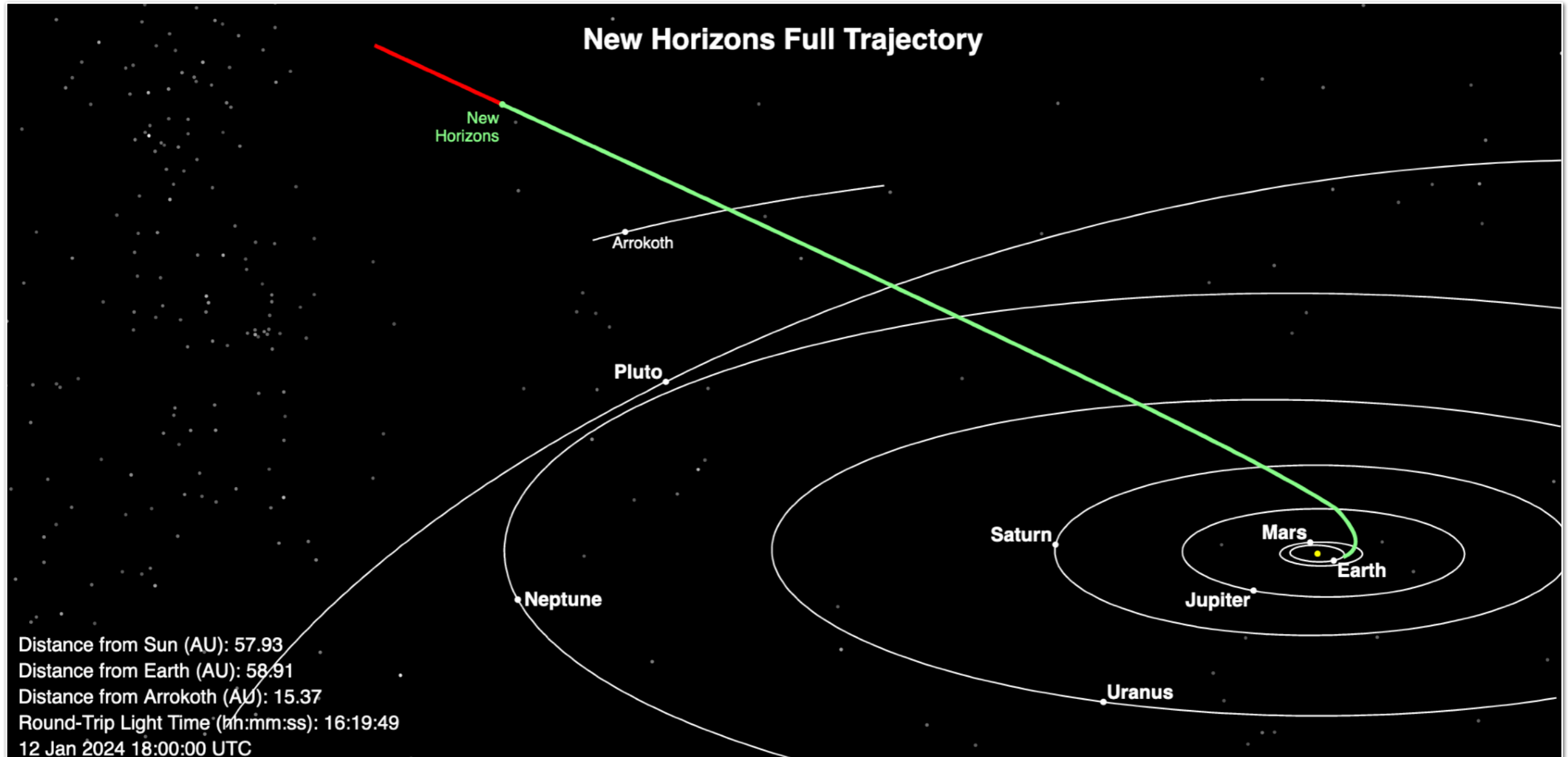
- Impacts on PVDF create PVDF depolarization charge
- Measured charge relates to mass of impactor, if velocity known

## Calibration curves:

- Relate ADC counts to depolarization charge
- Depend on detector # and temperature of electronics box

## Data set under review:

- Range: 2022/04/09 to 2023/04/02
- File cadence: daily
- Contents: .fits / .lbl



# Data set

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## L1 data:

- nh-a-sdc-2-kem2-v1.0
- ADC (engineering) units

## L2 data:

- nh-a-sdc-3-kem2-v1.0
- Physical units (e.g. grams)

## Ancillary data:

- Calibration curves used for L1 to L2
- Detection threshold values
- Data flags
- Spacecraft ephemeris data (pointing, velocity)
- Documentation for New Horizons / SDC

Can the dataset be understood without any external documentation it references, or should the information in said external references be incorporated into the dataset?

- One needs to refer to the instrument paper / SOC ICD / other documents to understand / interpret the data
  - These references are present in the PDS 'document' folder

If reviewing calibrated data, does the documentation fully explain the calibration process and contain all necessary parameters needed to repeat it?

- Yes
  - Calibration process is well documented in `soc_inst_icd.pdf` and `calinfo.txt`
  - The calibration process can be repeated from these documents

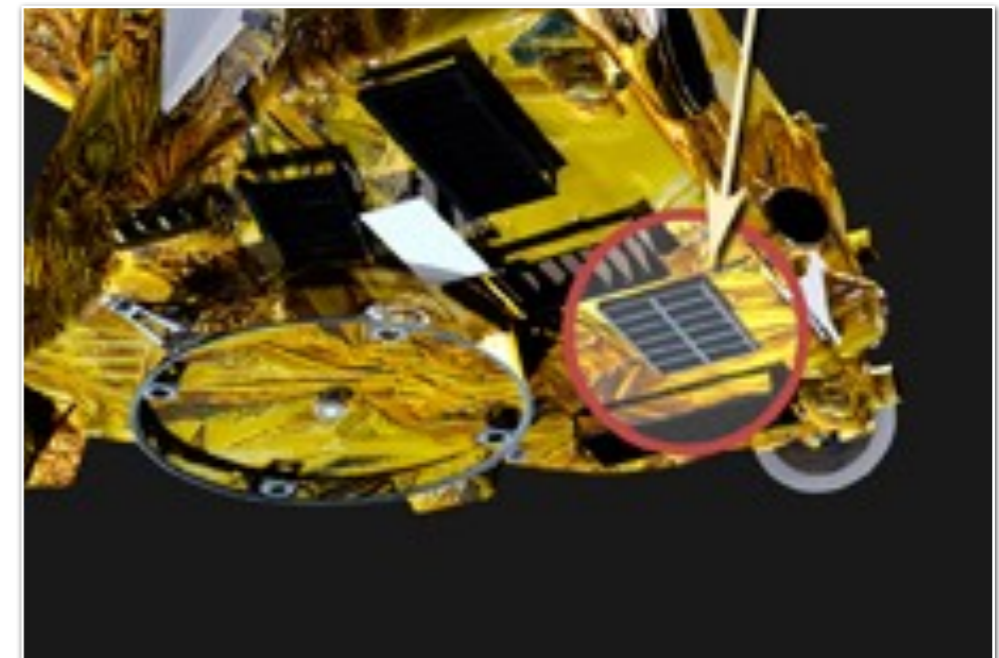


Does the dataset contain all documentation needed to use and understand its data without prior knowledge?

- **Mostly.** Some gaps.
  - Could not easily find detector #'s (e.g. which one is #1?)
  - Could not easily find mounting location of reference detectors
    - backside of a support panel? Which support panel?
  - Data flags not clear
    - two different 'OK' Flags present for Coincidence Flag

Is the provided documentation well organized, clear and self-consistent?

- **Yes.**
  - Documentation was straightforward to navigate
  - Mostly clear (see above)
  - Was self-consistent



Are the descriptions and scientific content contained inside the PDS labels sufficient to understand their corresponding data products?

Yes.

Filename: /Users/malaspina/Desktop/Papers/Reviewed Papers/202401 -- PDS SDC New Horizons/nh-a-sdc-2-kem2-v1.0/data/20220409\_051586/sdc\_0515865127\_0x700\_eng.fit

No.	Name	Ver	Type	Cards	Dimensions
0	PRIMARY	1	PrimaryHDU	311	()
1	DATA	1	BinTableHDU	27	29R x 6C
2	HOUSEKEEPING_SDC	1	BinTableHDU	29	0R x 9C
3	HOUSEKEEPING_0X004	1	BinTableHDU	89	0R x 37C
4	HOUSEKEEPING_0X00D	1	BinTableHDU	27	0R x 8C
5	HOUSEKEEPING_0X00A	1	BinTableHDU	29	0R x 5C
6	THRUSTERS	1	BinTableHDU	121	0R x 28C



No data in housekeeping?

Are the descriptions and scientific content contained inside the PDS labels sufficient to understand their corresponding data products?

Yes.

Filename: /Users/malaspina/Desktop/Papers/Reviewed Papers/202401 -- PDS SDC New Horizons/nh-a-sdc-2-kem2-v1.0/data/20220409\_051586/sdc\_0515865127\_0x700\_eng.fit

```
(<function print>,  
XTENSION= 'BINTABLE'      / binary table extension  
BITPIX =                   8 / array data type  
NAXIS =                     2 / number of array dimensions  
NAXIS1 =                   11 / length of dimension 1  
NAXIS2 =                   29 / length of dimension 2  
PCOUNT =                   0 / number of group parameters  
GCOUNT =                   1 / number of groups  
TFIELDS =                  6 / number of table fields  
TTYPE1 = 'Copy Number'  
TFORM1 = 'B      '  
TTYPE2 = 'Channel ID'  
TFORM2 = 'B      '  
TTYPE3 = 'Zero Fill'  
TFORM3 = 'B      '  
TTYPE4 = 'Threshold'  
TFORM4 = 'I      '  
TSCAL4 =                   1  
TZERO4 =                   32768  
TTYPE5 = 'Magnitude'  
TFORM5 = 'I      '  
TSCAL5 =                   1  
TZERO5 =                   32768  
TTYPE6 = 'Time Stamp'  
TFORM6 = 'J      '  
TSCAL6 =                   1  
TZERO6 =                   2147483648  
EXTNAME = 'DATA      ' / extension name  
)
```



Are the descriptions and scientific content contained inside the PDS labels sufficient to understand their corresponding data products?

Yes.

Filename: /Users/malaspina/Desktop/Papers/Reviewed Papers/202401 -- PDS SDC New Horizons/nh-a-sdc-2-kem2-v1.0/data/20220409\_051586/sdc\_0515865127\_0x700\_eng.fit

Copy#, Channel ID, Zero Fill, Threshold, Magnitude, Timestamp

```
[(0, 10, 0, 63477, 63403, 511842515)
(0, 10, 0, 63477, 63439, 511842555)
(0, 10, 0, 63477, 63447, 511842590)
(0, 10, 0, 63477, 63499, 511842640)
(0, 10, 0, 63477, 63449, 511842660)
(0, 10, 0, 63477, 63415, 511842689)
(0, 10, 0, 63477, 63460, 511842694)
(0, 10, 0, 63477, 63489, 511842803)
(0, 10, 0, 63477, 63497, 511842808)
(0, 10, 0, 63477, 63493, 511842851)
(0, 10, 0, 63477, 63491, 511842853)
(0, 10, 0, 63477, 63398, 511842864)
(0, 10, 0, 63477, 63365, 511842868)
(0, 10, 0, 63477, 63454, 511842882)
(0, 10, 0, 63477, 63451, 511842990)
(0, 10, 0, 63477, 63493, 511842995)
(0, 10, 0, 63477, 63383, 511843011)
(0, 10, 0, 63477, 63489, 511843017)
(0, 10, 0, 63477, 63483, 511843032)
(0, 10, 0, 63477, 63458, 511843086)
(0, 4, 0, 63541, 63477, 511843334)
(0, 4, 0, 63541, 63087, 511843334)
(0, 4, 0, 63541, 63414, 511843334)
(0, 12, 0, 63450, 63402, 511843334)
(0, 12, 0, 63450, 63183, 511843334)
(0, 3, 0, 63519, 63355, 511844415)
(0, 11, 0, 63557, 62298, 511847355)
(0, 6, 0, 63593, 62581, 511849409)
(0, 13, 0, 63589, 63155, 511851736)]
```

Are the descriptions and scientific content contained inside the PDS labels sufficient to understand their corresponding data products?

Yes.

Filename: /Users/malaspina/Desktop/Papers/Reviewed Papers/202401 -- PDS SDC New Horizons/nh-a-sdc-3-kem2-v1.0/data/20220409\_051586/sdc\_0515865127\_0x700\_sci.fit

No.	Name	Ver	Type	Cards	Dimensions	Format
0	PRIMARY	1	PrimaryHDU	312	()	
1	CALIBRATED_DATA	1	BinTableHDU	46	29R x 11C	

Are the descriptions and scientific content contained inside the PDS labels sufficient to understand their corresponding data products?

Yes.

Filename: /Users/malaspina/Desktop/Papers/Reviewed Papers/202401 -- PDS SDC New Horizons/nh-a-sdc-3-kem2-v1.0/data/20220409\_051586/sdc\_0515865127\_0x700\_sci.fit

```

XTENSION= 'BINTABLE'           /Binary table written by MWRFFITS
v1.4a     BITPIX =              8 /Required value
NAXIS =   2 /Required value
NAXIS1 =  80 /Number of bytes per row
NAXIS2 =  29 /Number of rows
PCOUNT =   0 /Normally 0 (no varying arrays)
GCOUNT =   1 /Required value
TFIELDS =  11 /Number of columns in table
COMMENT
COMMENT *** End of mandatory fields ***
COMMENT
EXTNAME = 'CALIBRATED_DATA' /
SDC_VER = '5.0.0 ' /
COMMENT
COMMENT *** Column names ***
COMMENT
TTYPE1 = 'UTC_TIME ' /
TTYPE2 = 'MET ' /
TTYPE3 = 'CHANNEL ' /
TTYPE4 = 'CHARGE ' /
TTYPE5 = 'MASS ' /
TTYPE6 = 'MASS_THRSH ' /
TTYPE7 = 'M_SIGPLUS ' /
TTYPE8 = 'M_SIGMINUS ' /
TTYPE9 = 'COINCIDENT_QUALITY_FLAG ' /
TTYPE10 = 'THRUSTER_QUALITY_FLAG ' /
TTYPE11 = 'IMP_VEL ' /
COMMENT
COMMENT *** Column formats ***
COMMENT
TFORM1 = '20A ' /
TFORM2 = 'J ' /
TFORM3 = 'I ' /
TFORM4 = 'D ' /
TFORM5 = 'D ' /
TFORM6 = 'D ' /
TFORM7 = 'D ' /
TFORM8 = 'D ' /
TFORM9 = '4A ' /
TFORM10 = '2A ' /
TFORM11 = 'D ' /
COMMENT
COMMENT *** Unsigned integer column scalings ***
COMMENT
= 1 /
2147483648 /
TZERO2 = TSCAL2
END
    
```

Are the descriptions and scientific content contained inside the PDS labels sufficient to understand their corresponding data products?

Yes.

Is all significant meta data included directly in the PDS labels?

Yes.

Do the labels provide all essential description of data values directly in the label, instead of deferring them to external references or documentation?

Mostly. Some need additional documentation:

- e.g. L1: HOUSEKEEPING\_0X004

Can the data be read programmatically using only the information contained in the PDS labels?

Yes.

Used astropy packages

Does the data look physically reasonable when examining it by eye or via a display tool?

Yes

When displaying the data as plots or images, are there any unexpected deviations?

Yes

- High density of 'coincidence' extra counts at start and end of data set
- Fluxes systematically dissimilar across the sensor (?)
  - Channels 1-7 have ~600 counts / year each (?)
  - Channels 8-14 have ~450 counts / year each (?)
  - Calibration channels get more hits than valid channels (?)

Formulate a scientific inquiry and attempt to use the data to answer the inquiry.

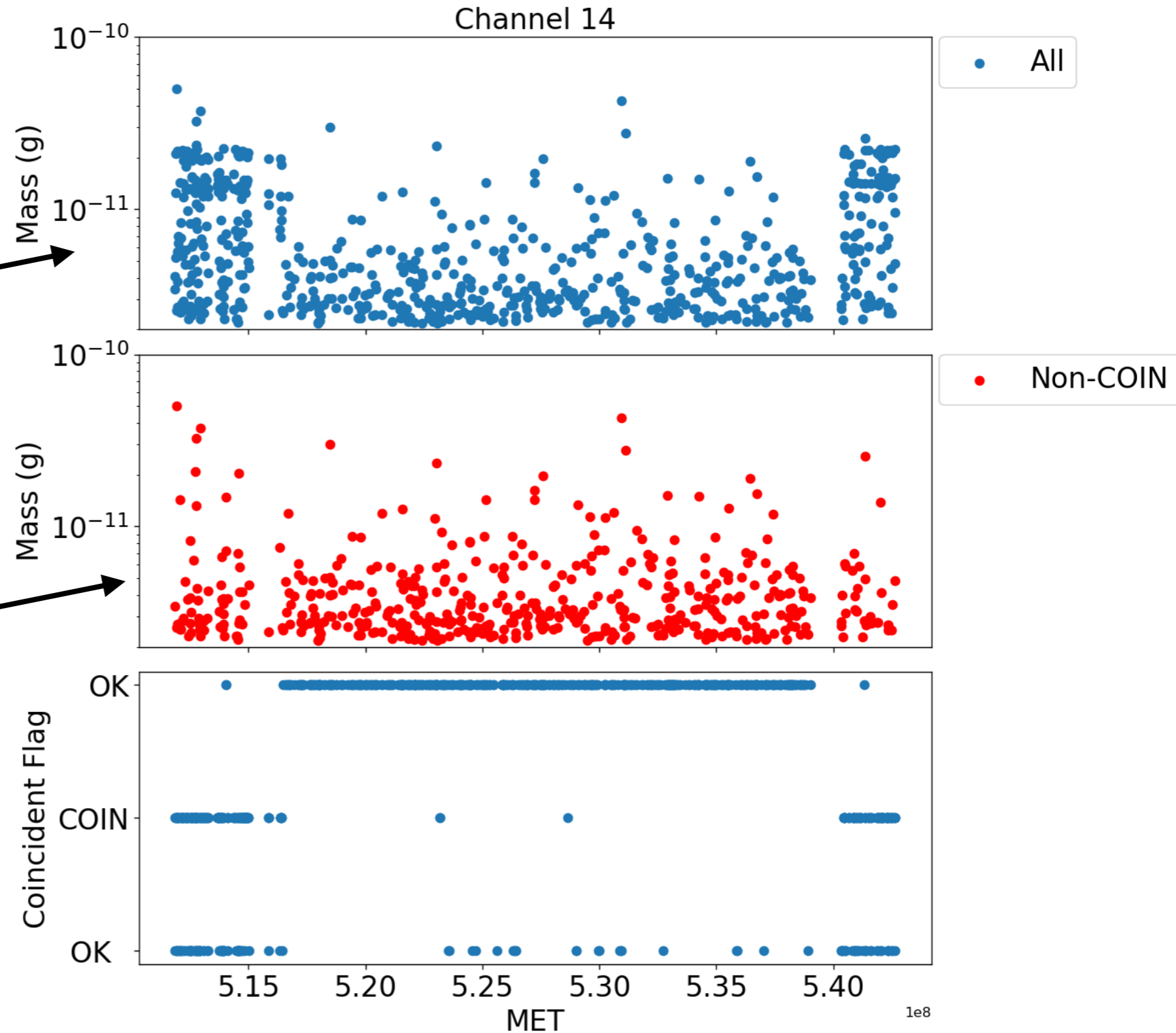
Physically reasonable?  
Unexpected deviations?

Mostly.

High density of  
COINCIDENCE events  
at start / end of data  
set?

Data gaps near start /  
end of interval?  
Bracketing 'bad' data?

Multiple 'OK' Flags?  
What's the difference?





Physically reasonable?  
Unexpected deviations?

- Ch 1 - 7 see different hits than 8 - 14
- Min mass different on every channel

Calibration channel

Damaged channel

Calibration channel

Channel	Min Mass (g)	Total hits	Total valid hits (non-COIN)
1	2.32E-12	891	688
2	2.34E-12	826	621
3	2.30E-12	878	665
4	2.26E-12	857	645
5	2.14E-12	883	662
6	2.34E-12	828	624
7	1.84E-12	835	633
8	2.46E-12	633	431
9	2.50E-12	678	478
10	2.47E-12	637	437
11	2.73E-12	161	108
12	2.54E-12	702	489
13	2.51E-12	636	390
14	2.17E-12	684	482